Space Weather Technical Forecast

Issued on Wednesday, 18 January 2023 at 00:36 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Further R1/R2 Radio Blackouts likely. G1/Minor Geomagnetic Storms likely Days 1 and 2 (18-19 Jan), risk declining later in the period.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate over the past 24 hours, peaking with an M1.8 flare at 17/2329 UTC. This flare emanated from the largest and most complex region on the disk, AR3190 in the southeast. AR3192 in the northeast is also a large region which appeared to lose its delta spot, but a new one has recently formed. The remaining seven regions appear stable for now with some regions showing signs of fading.
No new Earth-directed CMEs have been observed in available coronagraph imagery. There are numerous mostly small filaments on the disc at present, however the largest currently straddles the solar meridian near 30S and could give an Earth-directed CME should it lift-off the Sun.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by DSCOVR and ACE, showed a gradual decline to ambient levels, before a CME arrived at 17/2115 UTC. Wind speeds were slightly elevated to start, slowly declining to ambient, before jumping back to slightly elevated around 450 km/s as the CME arrived. The density has been average or slightly above, but jumped to around 20 ppcc when the CME arrived. The IMF was weak, but became moderate at around 15nT with the CME arrival. The north-south component varied weakly, but became moderately southward directed after the CME arrived down to -12 nT. The phi angle was initially positive (away from the Sun), but became more variable from around 17/1500 UTC. Geomagnetic activity was Quiet, with an Unsettled interval between 17/2100-2359 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.
High energy electron flux (greater than 2 MeV) has been at background to moderate levels, peaking at 553 pfu at 17/2235 UTC. The 24-hour integrated electron fluence stayed below the Active threshold on a fairly flat trend, reaching 1.47e7 integrated pfu at 18/0001 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be moderate, with a slight chance of reaching high levels. There are numerous regions on the disk, but the most obvious candidates for a significant flare are AR3190 and AR3192.

Solar Wind / Geomagnetic Activity: A recent CME arrival is now giving increased geomagnetic activity at Earth, with effects from this likely to last through much of Day 1 (18 Jan). A second CME that was launched on 14 January may also give a glancing blow either late on Day 1 or early on Day 2 (19 Jan). In addition, two small coronal holes may give some weak high speed stream (HSS) influence late Day 1 into early Day 2 with wind speeds up to around 500 km/s. A further HSS is possible from CH68 during Day 3 (20 Jan).
Geomagnetic activity is expected to often be Unsettled to Active with G1/Minor Storm intervals likely on Days 1 and 2, the risk declining slightly during Days 3 and 4. There is also a chance of an isolated G2/Moderate Storm interval, mainly on Day 1, but with a declining risk into Day 2.

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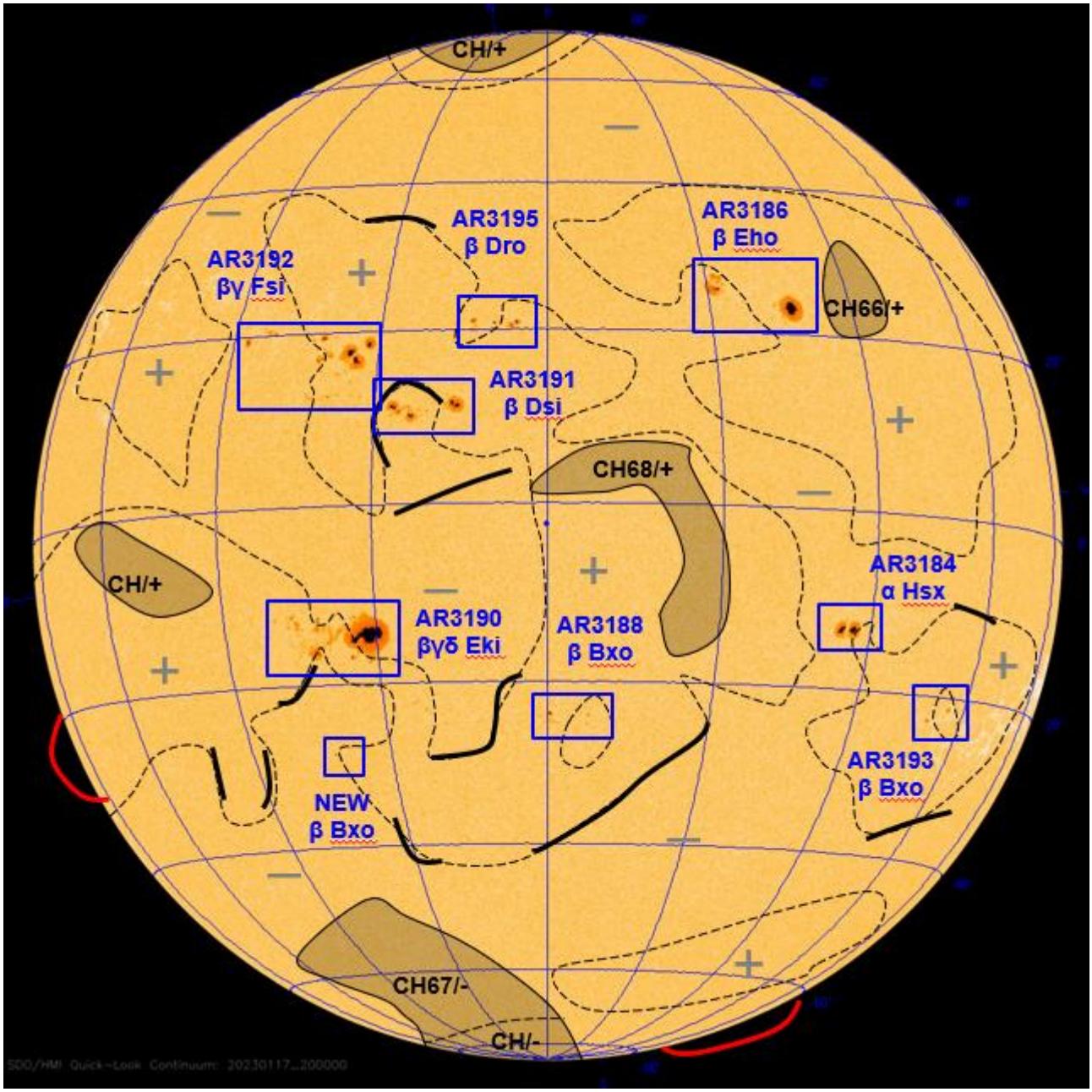
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly background levels, but with a slight chance of reaching S1 or greater through the period.
High energy electron flux reached moderate levels over the past 24 hours, but the recent CME arrival is expected to suppress levels in the near term. An increase is then possible later in the period. As such, electron fluence is likely to stay below the Active threshold for much of this period, but with an increasing trend into Day 4.

Figure 1. Solar Analysis Valid 17/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A recent CME arrival, likely one that was emitted on 15 January by AR3188, is now giving increased geomagnetic activity at Earth, with effects from this likely to last through much of Day 1 (18 Jan). A second CME that was launched on 14 January from AR3182 may also give a glancing blow either late on Day 1 or early on Day 2 (19 Jan).

In addition, two small coronal holes - CH65 and 66 - may give some weak high speed stream (HSS) influence late Day 1 into early Day 2. They are quite different from the previous rotation, and as such persistence methods are not particularly helpful. However, MOSWOC Enlil does suggest that a fast wind of up to around 500 km/s may arrive, with any CIR perhaps bolstered by the possible CME glance from the 14 January CME. A further HSS is possible from CH68 during Day 3 (20 Jan), although this appears to be a much weaker feature than the previous rotation. The phasing of all of these features is of lower confidence, but at least some degree of enhanced geomagnetic activity is expected through much of this period.

Geomagnetic activity is expected to often be Unsettled to Active with G1/Minor Storm intervals likely on Days 1 and 2, the risk declining slightly during Days 3 and 4. There is also a chance of an isolated G2/Moderate Storm interval, mainly on Day 1, but with a declining risk into Day 2.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	70	50	40	20
Strong	G3	No	2	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/0900	Partial	AR3182	SW	400 km/s	18/2359 UTC	Glancing blow possible

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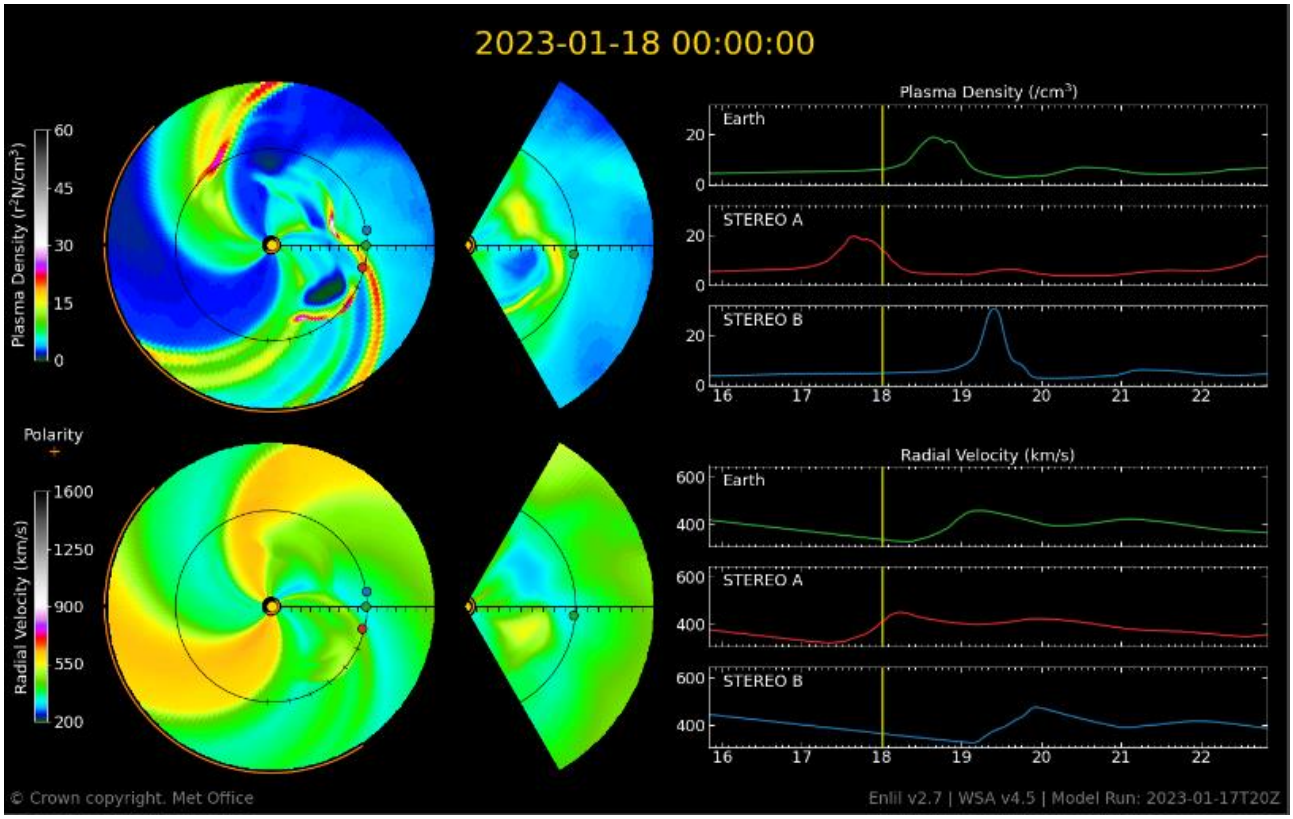
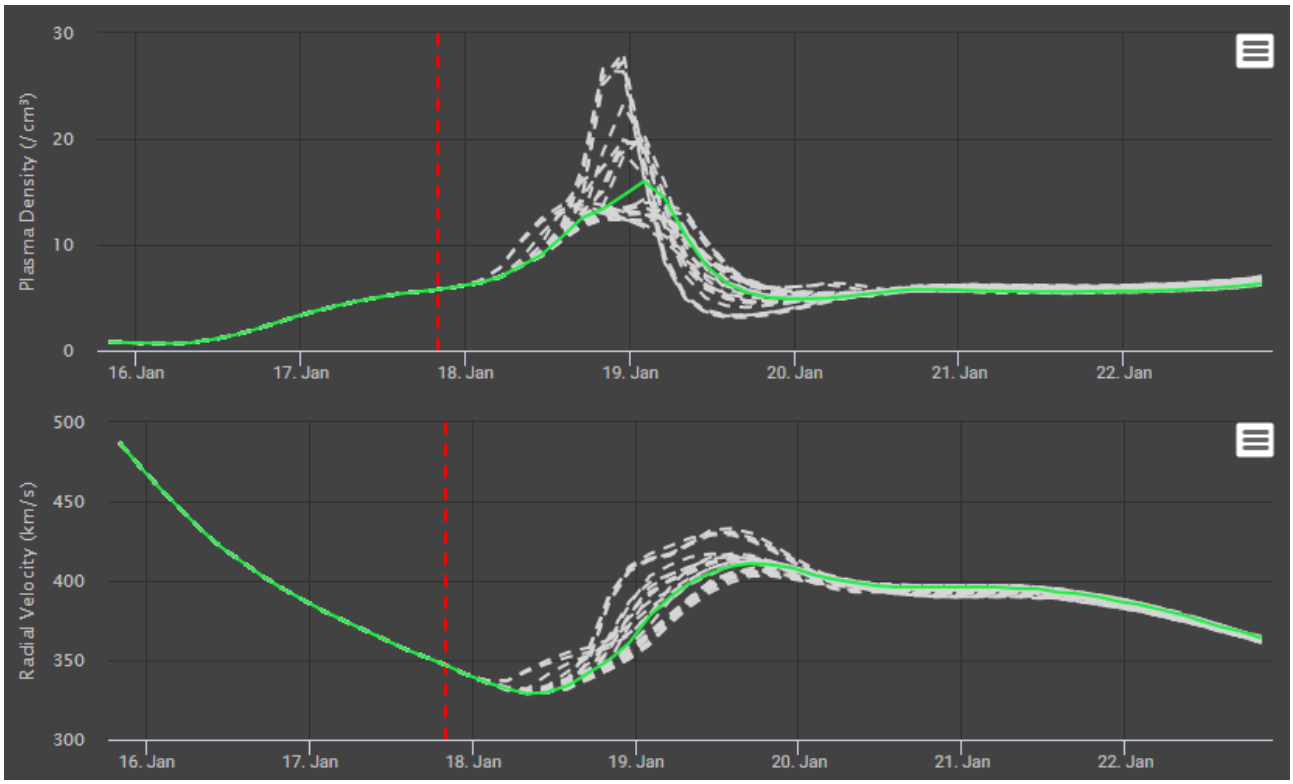
Figure 2: MOSWOC Enlil and ensemble, showing a possible CME arrival sometime around 18/2359 UTC. Enlil is also suggesting a weak HSS arriving around the same time.





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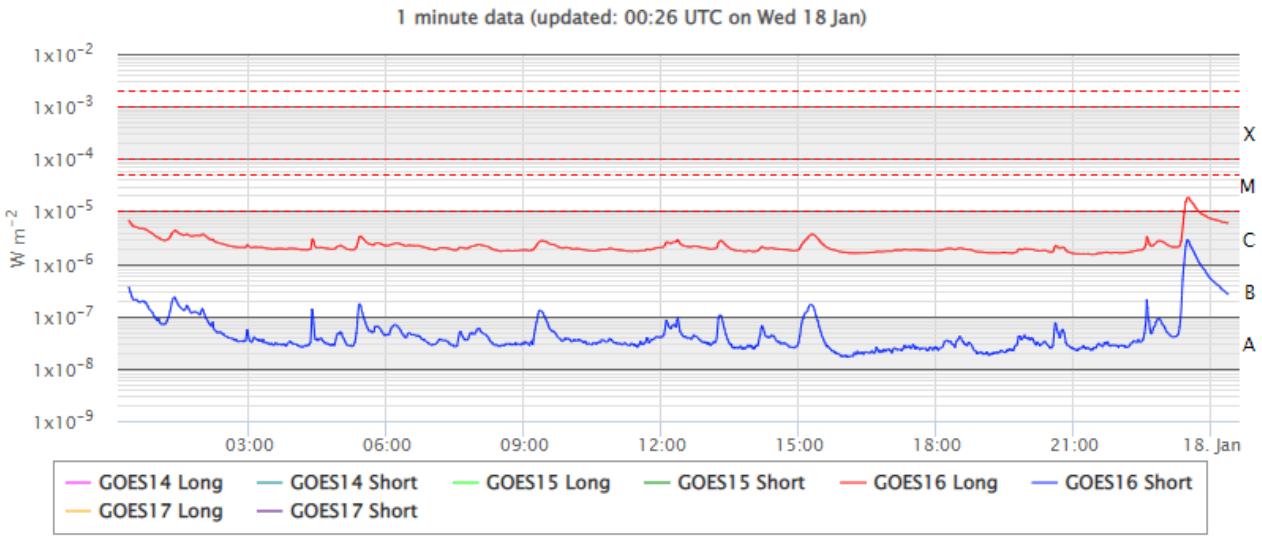
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate through the past 24 hours. Activity has been lower than expected given the complex and congested solar disc, however it is likely to be a result of the maturity and slowing growth trends of many of the sunspot regions. That said, AR3190 (Eki/Beta-Gamma-Delta) and AR3192 (Fsi/Beta-Gamma-Delta) both remain relatively large and complex regions as both have small and weak delta spots. The other regions on the visible disc at present appear largely stable, with some appearing to fade a little.

Far-side soundings suggest further regions may rotate onto the disc in the coming days, probably acting to maintain the risk of M-class flares through this period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: X-ray trace from GOES 16 showing one M-flare in the last 24 hours, from AR3190.



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux is currently at background levels.
While no recent S1+ events have been observed at GEO, the sheer number of both front and far-sided complex groups dictates an elevated risk. While the relative contribution to the risk will decrease through the coming days for Ex-3182, both AR3190 and AR3192 bring an increasing risk as they rotate westwards. As such, a slight chance of S1 or greater continues through this four day period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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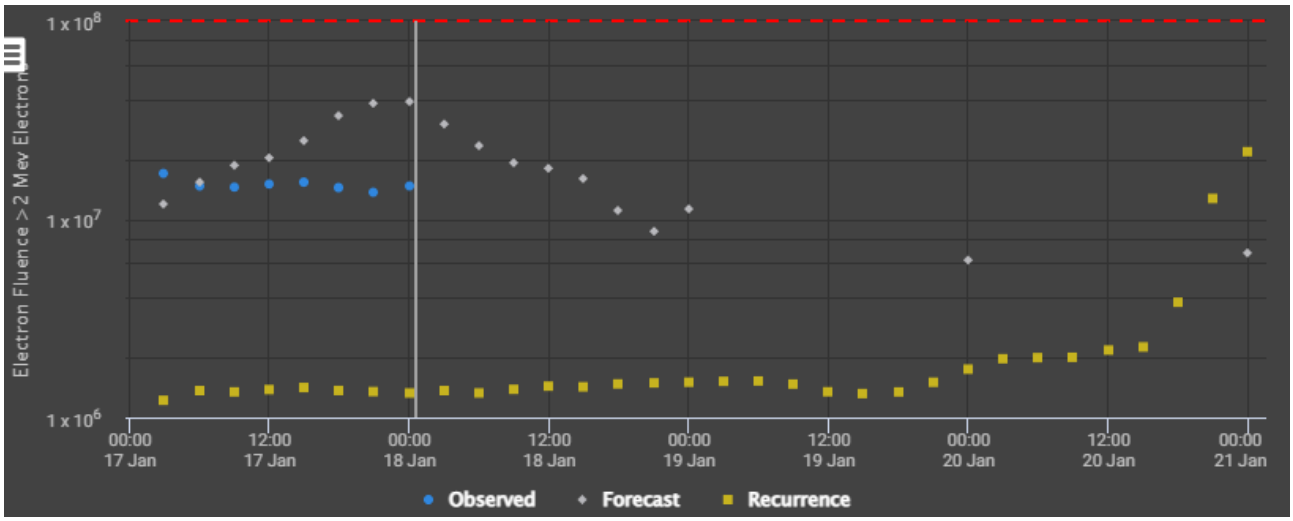
High Energy Electrons Event (≥ 2MeV):
High energy electron flux reached moderate levels over the past 24 hours, but the recent CME arrival is expected to suppress this in the near term. The possibility of another glancing blow from a further CME, perhaps combined with a weak HSS, is likely to continue the suppression into Day 2 (19 Jan) with a further HSS likely on Day 3 (20 Jan). An increase is then possible later in the period, probably on Day 4 (21 Jan), once the CME and HSS have begun to wane. It is difficult to judge the likelihood of significant electron charging occurring during this period until we see the strength of any HSS, however, so confidence in this is low.

As such, electron fluence is likely to stay below the Active threshold for much of this period, but with an increasing trend into Day 4. MOSWOC REFM is showing a level trend through the next 3 days, which is reasonable.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM showing a flat trend through the next three days.



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